International Journal of Innovative
Computing, Information and Control
Volume **7**, Number **4**, April **2011**

ICIC International ©2011 ISSN 1349-4198
pp. 1565–1576

DELAY-DEPENDENT STABILITY FOR VECTOR NONLINEAR STOCHASTIC SYSTEMS WITH MULTIPLE DELAYS

Michael Basin and Dario Calderon-Alvarez

Department of Physical and Mathematical Sciences
Autonomous University of Nuevo Leon
Cd. Universitaria, San Nicolas de los Garza, Nuevo Leon 66450, Mexico
mbasin@fcfm.uanl.mx; mbasin2007@gmail.com; dcalal@hotmail.com

Received November 2009; revised March 2010

Abstract. *Global asymptotic stability conditions for vector nonlinear stochastic systems with multiple state delays are obtained based on the convergence theorem for semimartingale inequalities, without assuming the Lipschitz conditions for nonlinear drift functions. Obtaining the delay-dependent stability conditions for nonlinear stochastic time-delay systems leads to a significant advantage in the nonlinear control theory and practice, since it enables one to address the stabilization problems for nonlinear systems, influenced by stochastic disturbances, whose dynamics is subject to multiple time delays in nonlinear functions, which make the LMI technique inapplicable. The Lyapunov-Krasovskii and degenerate functionals techniques are used. The derived stability conditions are directly expressed in terms of the system coefficients. Nontrivial examples of nonlinear systems satisfying the obtained stability conditions are given.*
Keywords: Delay-dependent stability, Vector nonlinear system, Multiple time delays

1. **Introduction.** The stability and stabilizability problems for time-delay systems have been extensively studied in recent years due to direct applicability of the obtained results to various technical problems [1, 5, 23]. Initiated in the background works [6, 7, 8], the stability theory for linear time-delay systems is now actively being developed. To prove stability results for a selected class of linear time-delay systems, the Lyapunov-Krasovskii or Lyapunov-Razumikhin functionals are applied in the framework of the Lyapunov direct method. Two types of stability conditions can be obtained: delay-independent, establishing stability for all possible delay values or delay-dependent, corresponding to some restricted values of delay shifts. While the first type of conditions is comprehensive but conservative, the second one is more selective, flexible, and, as a consequence, preferable. Some examples of delay-dependent stability conditions can be found in [2, 3, 13, 17, 18, 19, 20, 21, 26, 27, 28, 29] for various deterministic linear time-delay systems and in [4, 9, 10, 11, 14, 15, 30, 31, 32] for stochastic ones. Note that it is frequently needed to make a special transformation of an original time-delay system to obtain such stability conditions. Moreover, virtually all known results involving delay-dependent stability conditions have been obtained for linear time-delay systems, with certain or even uncertain coefficients.

This paper presents the stability conditions for vector nonlinear stochastic time-delay systems governed by multidimensional nonlinear Ito differential equations with multiple state delays and a nontrivial diffusion term. Obtaining the delay-dependent stability conditions for nonlinear stochastic time-delay systems leads to a significant advantage in the nonlinear control theory and practice, since it enables one to address the stabilization problems for nonlinear systems, influenced by stochastic disturbances, whose dynamics